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UNITED STATES DEPARTMENT OF AGRICULTURE
RURAL ELECTRIFICATION ADMINISTRATION
TECHNICAL STANDARDS DIVISION

SPECIFICATIONS
FOR
FREQUENCY MODULATED TWO-WAY RADIO EQUIPMENT
FOR
RURAL POWER SYSTEMS

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SPECIFICATIONS
FOR
FREQUENCY MODULATED TWO-WAY RADIO EQUIPMENT
FOR
RURAL POWER SYSTEMS

1. GENERAL

The equipment specified herein is to be used for two-way radio communication as licensed by the Federal Communications Commission in accordance with their published Rules and Regulations with particular reference to Part 17, Rules Governing Stations in the Utility Radio Service.

Definitions of terms and methods of measurement of performance of equipment specified herein shall be in accordance with those published by the Radio Manufacturers Association in their publication entitled "Minimum Equipment Standards Proposed for Mobile Service FM Transmitters and Receivers." Definitions of terms and methods of measurement of performance not specifically mentioned herein or in the above publications shall be in accordance with other nationally accepted standards.

All component parts and assemblies of the equipment specified herein shall be of high quality material and of good workmanship. Techniques and designs shall be in accordance with good engineering practice for communications equipment.

2. TYPE OF OPERATION

Equipment shall be capable of simplex operation. The land station transmitters and receivers, and the mobile station transmitters and receivers shall be capable of operating on one (1) power utility channel.

3. LAND STATION TRANSMITTERS

3.1 RADIO AND AUDIO FREQUENCY CHARACTERISTICS

Transmitters shall employ frequency modulation or phase modulation. Transmitters shall be designed for single channel operation within the specified band. Transmitters shall deliver full rated load output under the manufacturer's normal recommended loading conditions. Power ratings shall be specified as continuous or as intermittent or both.

Transmitter power outputs shall not fall below their rated values when tested in any ambient temperature between -20°C . and $+50^{\circ}\text{C}$., or when tested after being subjected to 95% relative humidity at 50°C . (non-operating) for 24 hours. During these test conditions all components must operate within the ratings specified in the applicable Joint Army-Navy specifications. Where JAN specifications are not available, proper ratings shall be determined by good engineering practice for communications equipment.

The minimum carrier center-frequency stability shall be $\pm 0.005\%$ over an ambient temperature range of -20°C . to $+50^{\circ}\text{C}$.

All spurious radiations shall be at least 60 db below the level of the output carrier for transmitters with a rated power output of 75 watts or less, and at least 70 db below the level of the output carrier for transmitters with a rated power output of more than 75 watts.

For 100% modulation, transmitters shall have a frequency swing of not more than ± 15 kilocycles if below 100 megacycles, and not more than ± 20 kilocycles if above 100 megacycles.

Transmitters shall have ample gain in the audio circuits so that 100% modulation may be obtained with speech at average voice level.

Total audio harmonic distortion shall not exceed 10% at 1000 cycles for 100% modulation.

For remote control applications, 100% modulation shall be obtained with a 1000 cycle signal working into a transmitter input impedance of approximately 600 ohms at a signal level of zero VU.

The over-all system audio frequency response, from transmitter microphone to receiver output, shall be flat within 6 db from 500 to 3000 cycles.

3.2 TRANSMITTER POWER SUPPLIES

Land station transmitters and associated equipment shall operate from a 110/120 volt, 60 cycle, single phase source.

No batteries shall be employed in any circuit.

Fuses or circuit breakers shall be provided to protect the equipment in the event of excessive current drain.

Transmitter power supply units may be mounted as an integral part of the transmitter or they may be mounted separately.

3.3 MECHANICAL CHARACTERISTICS

Transmitters shall be constructed on strong metal chassis with adequate coverage of wiring and component parts. Cabinets for land station transmitters and associated equipment shall be strongly constructed of sheet metal suitably finished. Cabinets may be designed for floor mounting, wall mounting or desk mounting.

Each transmitter whose rated output is greater than 75 watts shall be equipped with cylinder locks on all access doors.

Each transmitter whose rated output is greater than 75 watts shall be equipped with interlock switches on all doors that expose dangerous voltages when opened.

All tuning adjustments shall be readily accessible.

3.4 METERING

Means shall be provided for measuring voltages or currents to show proper operation of the transmitters.

4. LOCAL CONTROL UNITS

Provision shall be made in each land station transmitter and receiver for local control of the transmitter and receiver. Local control equipment shall include a loud speaker and a microphone or, at the option of the purchaser, a telephone type handset with push-to-talk switch and cradle or hang-up box.

5. REMOTE CONTROL UNITS

For applications where the land station equipment is to be remotely located from the dispatching point, the equipment shall be designed for remote control over a single telephone pair.

Remote control units shall be mounted in suitably finished cabinets or consoles.

Each remote control unit shall be provided with necessary audio amplifier to raise the level of the incoming signal from -10 VU to approximately one watt output. The outgoing signal level, into the telephone pair, shall be at least zero VU. Means shall be provided to regulate the level of the incoming and outgoing audio signals.

Control equipment shall be provided for the operation of local and remote pick-up receivers, when such receivers are required.

Means shall be provided for measuring voltages or currents to show proper operation of the remote control equipment.

Monitoring and control equipment shall be provided at each remote control point to fulfill the requirements of the Federal Communications Commission for remote control operation.

Each remote control unit shall be equipped with one or more loud speakers and a microphone mounted on a desk stand or, at the option of the purchaser, a suitable telephone type handset with push-to-talk switch and cradle or hang-up box.

6. LAND STATION RECEIVERS

6.1 RADIO AND AUDIO FREQUENCY CHARACTERISTICS

Receivers shall be designed for reception of frequency modulated signals on a single channel within the specified band.

The minimum sensitivity of the receivers shall be as follows:

25 to 44 megacycle band.....	1.5 microvolts
72 to 76 megacycle band.....	2.0 microvolts
152 to 162 megacycle band.....	3.0 microvolts

The minimum adjacent channel selectivity shall be at least 20 db.

The minimum alternate channel selectivity shall be at least 60 db.

All spurious responses shall be attenuated by at least 60 db.

Radiation from the receivers shall be at least 60 db below the carrier level of a 50-watt transmitter operating on the same antenna. This measurement should be made by actual radiation measurement.

The minimum stability of the local oscillators shall be $\pm 0.01\%$ when tested in any ambient temperature between -20°C . and $+50^{\circ}\text{C}$.

Receivers shall incorporate a squelch circuit which will completely cut off thermal noise, shot effect and other extraneous noise when a radio frequency carrier is not present.

Receivers shall be connected to the antenna through a coaxial transmission line. The receiver input impedance shall properly match the transmission line impedance so that the standing wave ratio shall not exceed 2 to 1.

Receivers shall not be harmed nor fail to operate over an ambient temperature range of $-30^{\circ}\text{C}.$ to $+60^{\circ}\text{C}.$, or after an eight-hour test at 90% relative humidity at $+50^{\circ}\text{C}.$

The over-all system audio frequency response, from transmitter microphone to receiver output, shall be flat within 6 db from 500 to 3000 cycles.

Receivers shall have a rated power output of at least one watt.

Total audio harmonic distortion shall not exceed 10% at rated output.

For remote control applications, the receiver audio output impedance shall match a standard telephone line and the output signal level shall not exceed +8 VU. Provision shall be made to operate a loud speaker at the receiver location.

6.2 RECEIVER POWER SUPPLIES

Land station receivers and associated equipment shall operate from a 110/120 volt, 60 cycle, single phase source.

No batteries shall be employed in any circuit.

Fuses or circuit breakers shall be provided to protect the equipment in the event of excessive current drain.

Receiver power supply units may be mounted as an integral part of the receiver or they may be mounted separately.

6.3 MECHANICAL CHARACTERISTICS

Receivers shall be constructed on strong metal chassis with adequate coverage of wiring and component parts. Cabinets for land station receivers and associated equipment shall be strongly constructed of sheet metal suitably finished. Cabinets may be designed for floor mounting, wall mounting or desk mounting.

All tuning adjustments shall be readily accessible.

6.4 METERING

Means shall be provided for measuring voltages or currents to show proper operation of the receivers.

7. LAND STATION ANTENNAS

Land station antennas shall be of the vertically polarized type, designed for attachment to the coaxial transmission line specified herein. Antenna termination impedance shall be such that the standing wave ratio on the transmission line shall not exceed 2 to 1. The antennas shall be capable of withstanding wind velocities up to 50 miles per hour when iced to 1/2 inch radial load. Necessary clamps shall be provided for attaching antennas to suitable masts.

8. TRANSMISSION LINES

Land station transmission lines shall be soft drawn copper 7/8 inch coaxial transmission line, or JAN Type RG17/U solid dielectric cable or its electrical equivalent.

All necessary accessory items shall be supplied, such as splicing material, end seals and clamps.

If gas type transmission line is supplied, it shall be gas tight and free from moisture. It shall be filled with dry air or a suitable dry inert gas to a pressure prescribed by the manufacturer. Necessary accessory equipment shall be supplied to maintain gas pressure in the line. Pressure may be maintained by manual or automatic means.

9. REPEATER OR RELAY STATIONS

Repeater or relay stations shall be supplied where required. They shall have the same applicable electrical and mechanical characteristics as the land station equipment specified herein, with the following exceptions: Separate authorized relaying channels shall be used for transmitting and for receiving. Antennas may be horizontally polarized if desired.

10. REMOTE PICK-UP RECEIVERS

Remote pick-up receivers with suitable antennas and associated equipment shall be supplied when required. They shall have the same applicable electrical and mechanical characteristics as the land station receivers specified herein.

Weatherproof housings shall be furnished at the option of the purchaser.

11. MOBILE TRANSMITTERS

11.1 RADIO AND AUDIO FREQUENCY CHARACTERISTICS

Transmitters shall employ frequency modulation or phase modulation. Transmitters shall be designed for single channel operation within the specified band. Transmitters shall deliver full rated load output under the manufacturer's normal recommended loading conditions. Power ratings shall be specified as continuous or as intermittent or both.

Transmitter power outputs shall not fall below their rated values when tested in any ambient temperature between $-30^{\circ}\text{C}.$ and $+60^{\circ}\text{C}.$, or when tested after being subjected to 95% relative humidity at $50^{\circ}\text{C}.$ (non-operating) for 24 hours. During these test conditions all components must operate within the ratings specified in the applicable JAN specifications. Where JAN specifications are not available, proper ratings shall be determined by good engineering practice for communications equipment.

The minimum carrier center-frequency stability shall be $\pm 0.01\%$ if below 50 megacycles and $\pm 0.005\%$ if above 50 megacycles in any ambient temperature between $-30^{\circ}\text{C}.$ and $+60^{\circ}\text{C}.$

All spurious radiations shall be at least 60 db below the level of the output carrier.

For 100% modulation, transmitters shall have a frequency swing of not more than ± 15 kilocycles if below 100 megacycles, and not more than ± 20 kilocycles if above 100 megacycles.

Transmitters shall have ample gain in the audio circuits so that 100% modulation may be obtained with speech at average voice level.

Total audio harmonic distortion shall not exceed 10% at 1000 cycles for 100% modulation.

The over-all system audio frequency response, from transmitter microphone to receiver output, shall be flat within 6 db from 500 to 3000 cycles.

11.2 TRANSMITTER POWER SUPPLIES

Mobile transmitters shall operate from a six-volt automobile storage battery and shall use a dynamotor or a vibrator type power supply. The six-volt input current shall not exceed 60 amperes for full rated transmitter output. Standby current shall be used only for tube heaters and indicator lamps, if required, and for necessary relays.

Fuses or circuit breakers shall be provided to protect the equipment in the event of excessive current drain.

Transmitter power supply units may be mounted as an integral part of the transmitter or they may be mounted separately.

11.3 MECHANICAL CHARACTERISTICS

Transmitters shall be constructed on strong metal chassis with adequate coverage of wiring and component parts. An easily removable dust cover shall be provided to house and shield the transmitter.

Provision shall be made for mounting the transmitter assembly and associated equipment to the vehicle body.

All tuning adjustments shall be readily accessible.

Weatherproof housings for the transmitter equipment shall be provided at the option of the purchaser.

11.4 METERING

Means shall be provided for measuring voltages or currents to show proper operation of the transmitters.

11.5 CONTROL UNITS

Mobile transmitters shall be provided with a dash control unit which contains the necessary controls and indicator lamps. All controls shall be clearly marked.

Each mobile transmitter shall be equipped with a suitable microphone with push-to-talk switch or, at the option of the purchaser, a telephone type handset with push-to-talk switch and cradle or hang-up box.

11.6 PRIMARY CABLES

Each transmitter shall be supplied with battery cables of ample size to assure full rated output.

12. MOBILE RECEIVERS

12.1 RADIO AND AUDIO FREQUENCY CHARACTERISTICS

Receivers shall be designed for reception of frequency modulated signals on a single channel within the specified band.

The minimum sensitivity of the receivers shall be as follows:

25 to 44 megacycle band.....	1.5 microvolts
72 to 76 megacycle band.....	2.0 microvolts
152 to 162 megacycle band.....	3.0 microvolts

The minimum adjacent channel selectivity shall be at least 20 db.

The minimum alternate channel selectivity shall be at least 60 db.

All spurious responses shall be attenuated by at least 60 db.

Radiation from the receivers shall be at least 60 db below the carrier level of a 50-watt transmitter operating on the same antenna. This measurement should be made by actual radiation measurement.

The minimum stability of the local oscillators shall be $\pm 0.01\%$ when tested in any ambient temperature between -30°C . and $+60^{\circ}\text{C}$.

Receivers shall incorporate a squelch circuit which will completely cut off thermal noise, shot effect and other extraneous noise when a radio frequency carrier is not present.

Receivers shall be connected to the antenna through a coaxial line. The receiver input impedance shall properly match the transmission line impedance so that the standing wave ratio shall not exceed 2 to 1.

Receivers shall not be harmed nor fail to operate over an ambient temperature range of -30°C . to $+60^{\circ}\text{C}$., or after an eight-hour test at 90% relative humidity at $+50^{\circ}\text{C}$.

The over-all system audio frequency response, from transmitter microphone to receiver output, shall be flat within 6 db from 500 to 3000 cycles.

Receivers shall have a rated power output of at least one watt.

Total audio harmonic distortion shall not exceed 10% at rated output.

12.2 RECEIVER POWER SUPPLIES

Mobile receivers shall operate from a six-volt automobile storage battery and shall use a dynamotor or vibrator type power supply. The six-volt input current shall not exceed 10 amperes.

Fuses or circuit breakers shall be provided to protect the equipment in the event of excessive current drain.

Receiver power supply units may be mounted as an integral part of the receiver or they may be mounted separately.

12.3 MECHANICAL CHARACTERISTICS

Receivers shall be constructed on strong metal chassis with adequate coverage of wiring and component parts. An easily removable dust cover shall be provided to house and shield the receiver.

Provision shall be made for mounting the receiver assembly and associated equipment to the body of the vehicle.

All tuning adjustments shall be readily accessible.

Weatherproof housings for the receiver equipment shall be provided at the option of the purchaser.

12.4 METERING

Means shall be provided for measuring voltages or currents to show proper operation of the receivers.

12.5 CONTROL UNITS

Each mobile receiver shall be provided with a dash control unit which contains the necessary controls and indicator lamps. All controls shall be clearly marked. The dash control unit may be combined with the transmitter dash control unit or it may be separate.

12.6 CONNECTING CABLES

Each receiver shall be supplied with necessary cables for connection with associated equipment.

12.7 LOUD SPEAKERS

Each mobile receiver shall be provided with a loud speaker designed to match receiver output. Loud speakers shall be equipped with suitable mounting brackets and protective housings if required.

13. MOBILE ANTENNAS

A strongly constructed antenna of suitable electrical characteristics shall be supplied with each mobile transmitter. Antennas shall be equipped for vehicle mounting.

A coaxial transmission cable with suitable dielectric properties shall be used to connect the transmitter to the antenna. The standing wave ratio in the coaxial cable shall not exceed 2 to 1.

14. FREQUENCY CHECKING MONITORS

A frequency checking monitor shall be supplied at the option of the purchaser. It shall be designed for accurately checking the frequency of the receivers and transmitters, both land and mobile. Frequency checking monitors shall be capable of such accuracy as to insure compliance with the frequency tolerance requirements established by the Federal Communications Commission for this particular class of service.

15. TEST EQUIPMENT AND SPECIAL TOOLS

One or more test sets shall be supplied to measure equipment performance. All special tools necessary to service the equipment specified herein shall also be furnished. Test sets shall have prods or plugs with which to connect to the transmitters and receivers and associated equipment. Test equipment shall be designed to work in conjunction with the equipment supplied under these specifications.

16. INSTRUCTION MANUALS

One or more complete sets of instructions for servicing equipment furnished under these specifications shall be supplied with each land station.

17. MISCELLANEOUS

All mounting hardware, miscellaneous connecting cables and appurtenances which are necessary to carry out the installation of the equipment specified herein shall be supplied.